Design and Analysis of Canister Testing Chamber

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ABSTRACT: Canister is used for carrying, storing and launching of missile. During storage and launching, the canister is subjected to internal pressure of 45 kgf/cm^2 and external pressure of 9 kgf/cm^2.The canister is generally placed inside the testing chamber. Canister testing chamber is one of the most critical components in Defence Organization. The Primary objective of this paper is to design a canister testing chamber and predicting the failure performance of canister testing chamber using ANSYS a finite element analysis package.

The structure of the canister testing chamber is determined on the basis of empirical of gun design and experimental data of Ballistic Research Laboratories (BRL).First a three- Dimensional model of a canister chamber is made in Uni Graphics and then stress analysis is carried out using ANSYS. Contact analysis on canister testing chamber is also carried out using ANSYS to estimate the gap between contact surfaces of bolt region of canister testing chamber.

Key words: Canister, Testing Chamber, contact analysis, Von Misses stress.

I. INTRODUCTION

The shell of the test setup is made from IS: 2062 plates welded to get 11 meters length and diameter of the shell is 1.5 meters. One end of the test setup will have dished end welded integrally to the cylinder. The other end shall be a hinged door with proper sealing. One of the sides dished end is provided with screw rod to press the dummy dish end for leak proof joint which shall withstand the internal pressure during testing. The screw is actuated by a hand wheel provided through nut. The nut is fixed in a welded housing on the dished end. Between both the mating faces
rubber/gasket will be provided to avoid any leak of water during pressure testing.

II. COMPONENTS USED IN CANISTER TESTING CHAMBER

The following are the components which are used in canister.
1. Chamber shells
2. Canister dished ends
3. Support legs
4. Bolts
5. Pressure gauges

III. Modelling of Canister Testing Chamber

The NX software integrates knowledge-based principles, industrial design, geometric modelling, advanced analysis, graphic simulation, and concurrent engineering. The software has powerful hybrid modeling capabilities by integrating constraint-based feature modelling and explicit geometric modelling. In addition to modelling standard geometry parts, it allows the user to design complex free-form shapes such as airfoils and manifolds. It also merges solid and surface modeling techniques into one powerful tool set. The steps involved while developing the 3D model of a canister testing chamber:

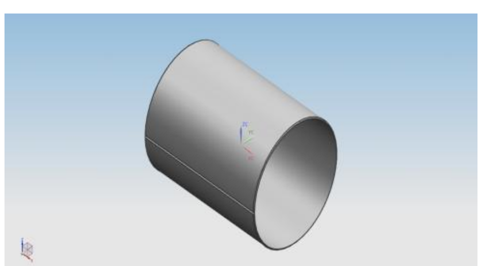


Fig 3.1 3D model of the chamber shell

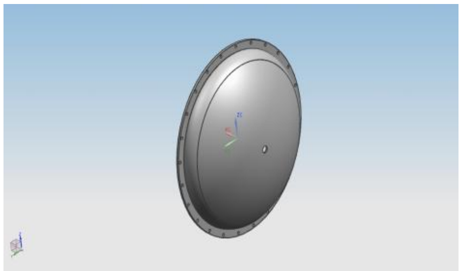


Fig 3.2 model of the shell head plate 1

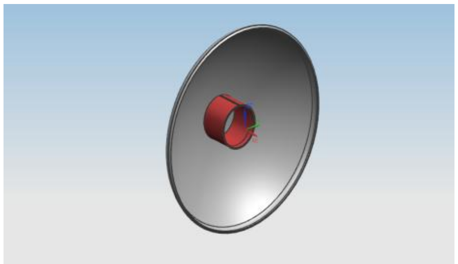


Fig 3.3 model of the shell head plate 2

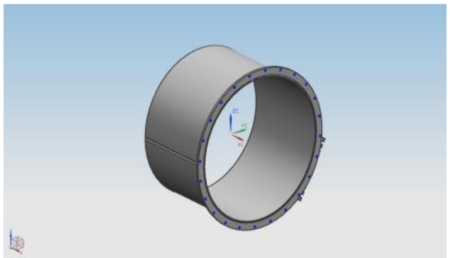


Fig 3.4 model of the spacer

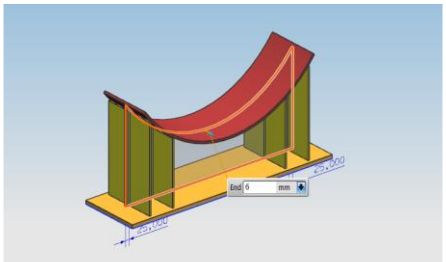


Fig 3.5 model of the bottom supports

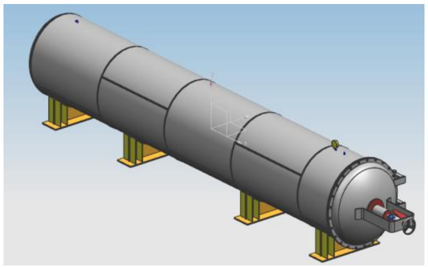


Fig 3.6 model of a canister testing chamber assembly

IV. ANALYSIS OF TESTING CHAMBER

Pressure Analysis

The canister testing chamber is meshed using shell 63 element type. It is a quad 4 node element. Thickness is given as the real constant.

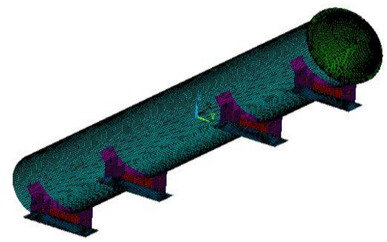


Fig 4.1Meshing of the canister testing chamber

Boundary Conditions

1. Base plates are constrained in all degrees of freedom
2. Head closure is bolted to chamber using Constraint equations – Simulating bolts
3. Internal pressure of 9 Kgf/cm^2 is applied
4. Gravity – 9810 mm/sec^2 is applied to simulate self weight

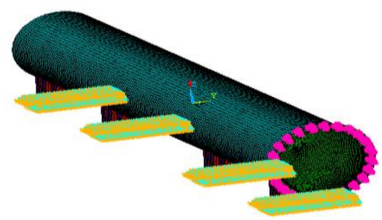
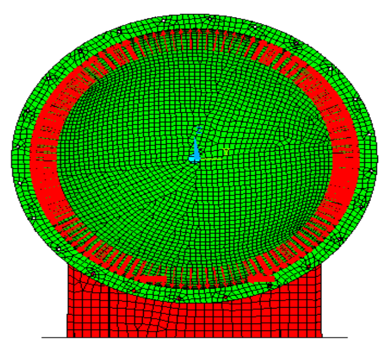


Fig 4.2 Applying gravity for self weight



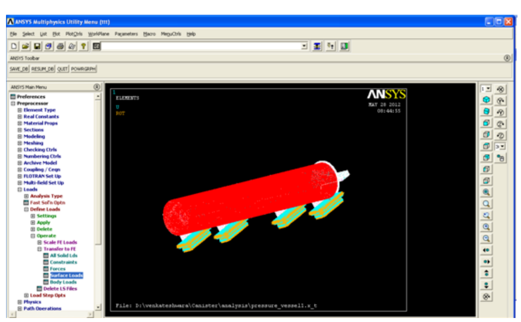


Fig 4.4 Loads condition on canitster testing chamber

The canister testing chamber is applied by loading conditions (pressure) upto 9 kgf/cm

V. Contact Gap Analysis

Contact gap analysis is a carried out at the bolting locations of the chamber to check for the leakage of the pressure to the atmosphere. Contact problems are highly nonlinear and require significant computer resources to solve. It is important to understand the physics of the problem and take the time to set up the model to run as efficiently as possible. Contact problems present two significant difficulties. First, we do not know the regions of contact until we've run the problem. Depending on the

loads, material, boundary conditions, and other factors, surfaces can come into and go out of contact with each other in a largely unpredictable and abrupt manner. Second, most contact problems need to account for friction. There are several friction laws and models to choose from, and all are nonlinear. Frictional response can be chaotic, making solution convergence difficult.
Fig 4.3 Application of Internal pressure of 9 Kgf/cm^2

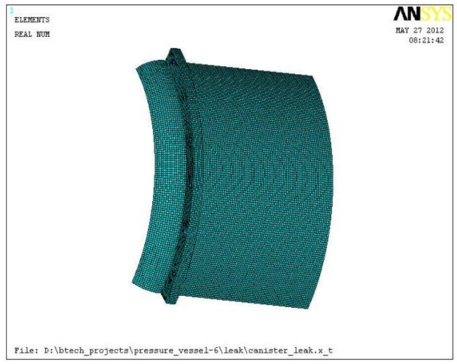


Fig 5.1 Mesh model of the Chamber used for Contact Gap Analysis

Calculation for M12 BOLT:
Bolt preload is computed as follows: Pi = T/(K D)
where P_i = bolt preload (called F_i in Shigley).
T = bolt installation torque. = 10858 N-mm
K = torque coefficient = 0.2
D = bolt nominal shank diameter (i.e., bolt nominal size) = 12mm
Torque coefficient K is a function of thread geometry, thread coefficient of friction m_c, and collar coefficient of friction m_c.
delta = P L/(E A)
P = bolt preload = 4524.1 N
L = bolt length = 50mm
E = bolt modulus of elasticity = 2e5 N/mm^2
A = bolt cross-sectional area = (p/4)*d^2
D = bolt nominal shank diameter = 12mm
delta = measured bolt elongation in units of length = 0.01mm

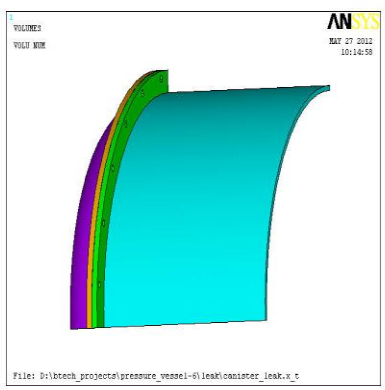


Fig 5.2 Contact created between the mating surfaces

near bolted region
Simillarly The Delata Values For M22 And M36 Bolts are.
Intial strain value for M22 bolt is:0.001
Intial strain value for M36 bolt is:0.0003

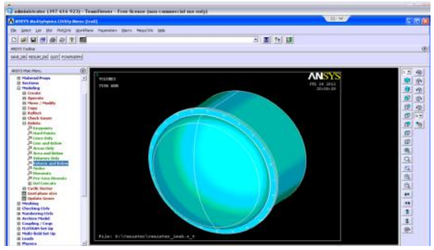


Fig 5.3 Model for the Contact Gap Analysis

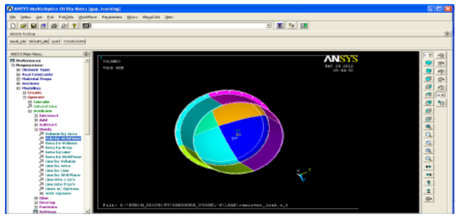


Fig 5.4 Dividing the model into Quarter parts

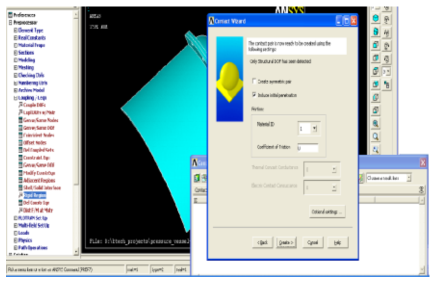


Fig 5.5 Creating surface to surface contact to Shell and Dished end

VI. RESULTS AND DISCUSSIONS

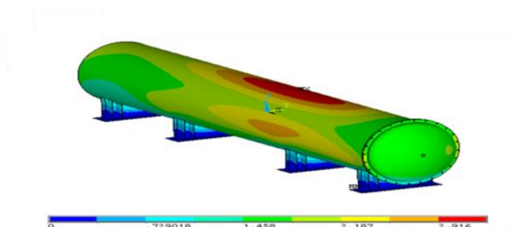


Fig 6.1 Total deflection of testing chamber

Total deflection of the canister testing chamber. Maximum total deflection of 3.2 mm is seen on the canister testing chamber.

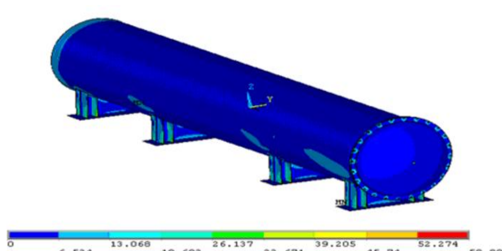


Fig6.2 von mises stress of testing chamber

Von Mises Stress on the canister testing chamber. Maximum Stress of 58N/mm^2 is seen on the canister testing chamber.

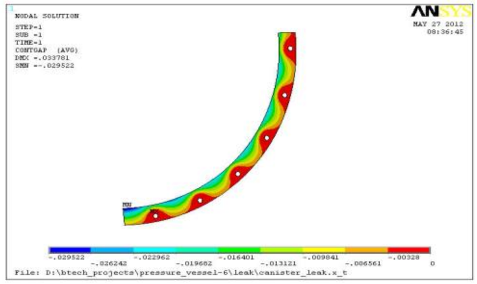


Fig 6.3 Contact Gap for M12 bolt

From the above Fig it can be observed that the VonMises stress is very high at bolt region and also there is an opening of 0.00328mm at the bolt locations. So It is recommended to check for the higher bolt diameter.so,the gap analysis is performed again for M22 bolt diameter.

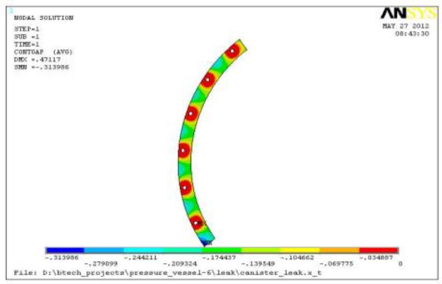


Fig 6.4 Contact Gap for M22 bolt

From the above Fig it can be observed that the VonMises stress is within the limit at bolt region but there is an opening of 0.0034mm at the bolt locations.So It is recommended to check for the higher bolt diameter.so,the gap analysis is performed again for M36 bolt diameter.

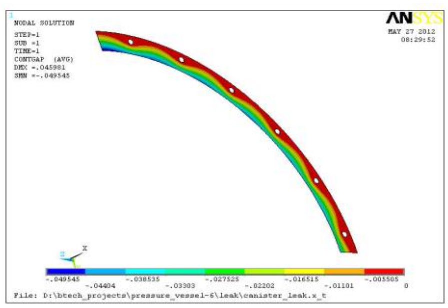


Fig 6.5 Contact gap for M 36 bolt

From the above Fig. it can be observed that the VonMises stress is 6 N/mm2 ,within the limit at bolt region and there is no opening at the bolt locations. The contact status is also observed as sticking at the bolting regions.So M36 bolts are the suitable bolt diameter to prevent the leakage of pressure to the atmosphere.

VII. CONCLUSION

In this paper a canister chamber is designed and tested for stresses and leakages using ANSYS simulation studies.
The following conclusions can be made from Simulation studies that are carried out in this thesis.

- The maximum vonMises Stress observed on the canister testing chamber is 58 Mpa.
- The maximum deflection observed on the canister testing chamber is 3.2mm.
- The Designed horizontal canister testing chamber is safe of the internal pressure of 9kgf/cm^2 as the yield strength of material used for canister testing chamber is 260N/mm2
- Nonlinear Contact Gap analysis performed on the canister testing chamber shows free from leakage of pressure.
- Contact gap analysis is suggests to use M36 Bolts which is gives a gap opening of 0mm and henceM36 bolts recommended for canister testing chamber to avoid the pressure leakage to the atmosphere.

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